A VERY EASY AND SHORT METHOD

OF FINDING THE

TRUE DISTANCE

BETWEEN THE

MOON and the SUN, or a fixed STAR,

FOR THE PURPOSE OF DETERMINING THE

LONGITUDE.

BY. J. GREENSWORD,

Teacher of Navigation, the Lunar Observations, &c. and Master of the United Society's School, in Trinity-Street, Rotherhithe.

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PRECEPT.

WITH the moon's apparent altitude and horizontal parallax, to be found in the Nautical Almanack, page 7, take the logarithm out of Table 9, Requiſite Tables, which reſerve, and alſo the correction of her altitude from Table 8, Requiſite Tables; to this add the refraction of the ſtar from Table 1, Requiſite Tables, or, if the obſervation be taken from the ſun, the difference between the ſun's parallax * and refraction; which, if the altitude of the ſun or ſtar be greater than that of the moon, take from the difference of the apparent altitudes; but add them together, if the altitude of the moon be the greater, and you will have the difference of the true altitudes, of which take half. Then to the logarithm from Table 9, Requiſite Tables, add the logarithmic ſine of the half ſum of the difference of the apparent altitudes and apparent diſtance, the logarithmic ſine of half their difference, and reject radius; double the logarithmic ſine of the half difference of the true altitudes, and, if this double logarithmic ſine be leſs than the logarithmic ſum radius rejected (above-mentioned) take it from that; but, if greater, take the logarithmic ſum radius rejected from it; then find the neareſt logarithm to this logarithmic remainder, but under, from a table of common logarithms, and note the correſpondent number to four places; take that logarithm from this, and reſerve the remainder, to the noted correſpondent number add 1, then ſeek the logarithm anſwering to this ſum, and to this logarithm add a difference to be taken out of the Table of Multipliers, pages 4 and 5, (as directed in page 3,) and halve the ſame. And if double the logarithmic ſine of the half difference of the true altitudes be leſs than the logarithmic ſum radius rejected (above-mentioned) add the logarithmic ſine of the half difference of the true altitudes to this half, and this laſt logarithmic ſum will be the logarithmic ſine of half of the true diſtance.

But, if the logarithmic ſum radius rejected (before-mentioned) be leſs than double the logarithmic ſine of the half difference of the true altitudes, († See Example 9,) to the above-mentioned half logarithm, add half the logarithmic ſum radius rejected (above-mentioned) and this laſt logarithmic ſum will be the logarithmic ſine of half of the true diſtance.

* The ſun's parallax in altitude is in Table 3, Requiſite Tables.

N. B. — How the longitude may be determined by the help of the true diſtance between the moon and the ſun, or a fixed ſtar, it ſhewn in every modern Epitome of Navigation.

The Explanation of the Table of Multipliers.

THE columns marked at the top Num. contain numbers beginning at 1,000 and ending at 8,999: Thoſe marked Mult. contain the multiplier correſpondent to each number oppoſite, and to the intermediate numbers. The column marked Diff. following, contains the differences to logarithms of ſeven places beſides the index, correſpondent to each number oppoſite, and to the intermediate numbers, from 9,000 to 9,999, and the column next to it contains alſo the multiplier correſpondent to each number oppoſite, and to the intermediate numbers.

What has been ſaid here ſufficiently explains the reſt of the Table.

Method of finding the Difference from this Table, which is to be added to the Logarithm anſwering to the noted correſpondent Number increaſed by 1, *mentioned in the Precept preceding.*

DIRECTION I. From 1,000 to 8,999, (incluſive) alſo from 10,00 to 68,49, (incluſive) and from 100,0 to 102,9, (incluſive) the product of the reſerved remainder by the multiplier correſpondent to the number anſwering to the logarithmic remainder, (mentioned in the precept) cutting off two figures to your right hand, is the difference.

DIRECTION II. From 9,000 to 9,999, (incluſive) alſo from 99,00 to 99,99, (incluſive) and from 999,0 to 999,9, (incluſive) multiply the difference in this table, anſwering to the number correſpondent to the logarithmic remainder, (mentioned in the precept) by the fourth figure of that number; to this add the reſerved remainder; the product of this ſum by the multiplier, correſpondent to the number anſwering to the logarithmic remainder, (mentioned in the precept) cutting off two figures to your right hand, is the difference.

DIRECTION III. From 63,50 to 98,99, (incluſive) and from 203,0 to 998,9, (incluſive) add the reſerved remainder to the logarithm correſpondent to the number anſwering to the logarithmic remainder, (mentioned in the precept) increaſed by 1.

DIRECTION IV. When the index of the logarithmic remainder (mentioned in the precept) is 3, to the logarithmic remainder add the difference between the next logarithm under the logarithmic remainder in a table of common logarithms, and the next greater; then, the half of this laſt logarithm is to be added either to the logarithmic ſine of the half difference of the true altitudes, or to half of the logarithmic ſum radius rejected (mentioned in the precept) as there directed.

DIRECTION V. When the index of the logarithmic remainder (mentioned in the precept) is 4, to the logarithmic remainder add one-tenth of the difference between the next logarithm under the logarithmic remainder, in a table of common logarithms, and the next greater; then the half of this laſt logarithm is to be added either to the logarithmic ſine of the half difference of the true altitudes, or to half of the logarithmic ſum radius rejected (mentioned in the precept) as there directed.

DIRECTION VI. When the index of the logarithmic remainder (mentioned in the precept) is 5, to the logarithmic remainder add one hundredth of the difference between the next logarithm under the logarithmic remainder, in a table of common logarithms, and the next greater; then the half of this laſt logarithm is to be added either to the logarithmic ſine of the half difference of the true altitudes, or to half of the logarithmic ſum radius rejected (mentioned in the precept) as there directed.

DIRECTION VII. When the index of the logarithmic remainder (mentioned in the precept) is 6, or upwards, add the half of the logarithmic remainder either to the logarithmic ſine of the half difference of the true altitudes, or to half of the logarithmic ſum radius rejected (mentioned in the precept) as there directed.

TABLE OF

Num.	Mult.	Num.	Mult.	Num.	Mult.	Num.	Mult.	Num.	Mult.	Num.	Mult.	Num.	Mult.	Num	Diff.*	Mult	Num.
1,000	,50	2,189	,68	3 089	,75	3,869	,79	4,809	,83	5,919	,86	7,279	,87	9,000	48 3	,90	10,00
1,029	,51	2,199	,69	3.099	,76	3,909	,80	4,839	,82	5.959	,85	7,309	,88	9,119	47,6	,89	10,89
1,079	,52	2,279	,70	3.239	,77	3.919	,79	4,859	,83	5.999	,86	7,429	,90	9,149	47.4	,91	12,09
1,119	,53	2,289	,69	3,249	,76	3,939	,80	4.969	,84	6.069	,85	7,449	,88	9,219	47,1	,90	12,49
1,159	,54	2,299	,70	3,259	,77	3.969	,79	4,999	,83	6.079	,86	7,559	,89	9,329	46,6	,89	12,69
1,199	,55	2,399	,71	3.309	,76	3,979	,80	5,029	,84	6,169	,87	7,669	,88	9,359	46.4	,91	13,29
1,259	,56	2,489	,72	3.339	,77	4,009	,81	5.079	,83	6.179	,86	7,699	.89	9,429	46,1	,90	13.39
1.319	,57	2,499	,71	3,349	,76	4,029	,80	5,089	,84	6,249	,87	7.749	.88	9.549	45.5	,89	13 79
1,359	,58	2,509	,72	3.359	,77	4,129	,81	5,149	,85	6,309	,86	7,839	,89	9 559	45,4	,92	13.89
1,409	,59	2,629	,73	3.439	,78	4,149	,80	5,169	,83	6,349	,87	7.959	,87	9 569	45.4	,91	13,99
1,479	,60	2,639	,72	3.459	,77	4,169	,81	5.209	,84	6.429	,85	7,979	,89	9.659	45.0	,90	14.49
1,519	,61	2,649	,73	3.469	,78	4,269	,80	5.249	,83	6,489	,87	8,129	,91	9.769	44.4	,92	14 69
1,609	,62	2,729	,74	3.509	,77	4,289	,81	5,269	,84	6,539	,88	8.149	,89	9.789	44,4	,91	14.99
1,679	,63	2,739	,73	3.529	,78	4,309	,82	5.339	,85	6.559	,86	8,279	,90	9.799	44.3	,92	15,09
1,739	,64	2,789	,74	3.579	,79	4,339	,81	5,349	,84	6,639	,88	8 359	,88	9 809	44.3	,91	16.59
1,749	,63	2,899	,75	3.609	,78	4,349	,82	5,409	,85	6,699	,86	8 449	,90	9,899	43.9	,90	16,69
1,759	,64	2,909	,74	3.639	,79	4,469	,81	5.439	,84	6.739	,88	8,559	,88	9.909	43.8	,91	16.79
1 829	,65	2,949	,75	3,659	,78	4,509	,82	5.469	,85	6.839	,86	8,609	,90	9.919	43,8	,90	16,89
1,889	,66	3 009	,74	3.679	,79	4,539	,81	5,639	,84	6,849	,87	8,749	,92	9.999	43,4	,92	16.99
1,989	,67	3.019	,75	3.759	,78	4,559	,82	5,699	,86	6.959	,89	8,769	,90	——	——	——	17,19
2,069	,68	3.029	,75	3.769	,79	4,659	,83	5.739	,84	6,979	,87	8,959	,92	99,00	43,8	,99	17,29
2,079	,67	3.039	,76	3.799	,80	4,699	,82	5,759	,85	7,069	,89	8,999	,90	99,29	43.7	,98	17,49
2,089	,68	3.049	,75	3,809	,79	4,709	,83	5.839	,86	7,129	,87	——	——	99,99	43,4	1,00	17,69
2,179	,69	3.079	,76	3,839	,80	4,759	,82	5,849	,85	7,179	,88			——	——	——	20,59
														999 0	43,5	1,00	
														999 9	43,4	1,00	

* To logarithms of seven places beside the index.

MULTIPLIERS.

Mult	Num.	Mult.	Num	Mult.	Num.	Mult	Num.	Mult.	Num.	Mult.	Num.	Mult.	Num.	Mult.	Num.	Mult.
,90	10,00	,91	21,89	,95	30 79	,97	36,39	,97	48 59	,99	56,99	,99	160,9	,99		
,89	10,89	,92	22,19	,96	30,89	,96	37.99	,98	48,69	,98	57,39	,97	162,9	1,00		
,91	12.09	,93	22,59	,95	30,99	,97	38,09	,97	49.19	,99	57,59	,99	163,9	,99		
,90	12,49	,92	22,69	,96	31,39	,96	38,69	,98	49.29	,98	58,19	,97	165,9	1,00		
,89	12,69	,93	25,09	,97	31,49	,97	38,79	,97	49 69	,99	58,39	,99	166,9	,99		
,91	13,29	,92	25,19	,96	31,59	,96	39,39	,98	49,89	,98	58,99	,97	167,9	1,00		
,90	13,39	,93	26,59	,97	31,69	,97	39,49	,97	50,29	,99	59,19	,99	168,9	,99		
,89	13 79	,94	26,69	,96	33,59	,98	39 79	,98	50,49	,98	59 79	,97	170,9	1,00		
,92	13,89	,93	26,79	,97	33 69	,97	39,89	,97	50 89	,99	59 99	,99	171,9	,99		
,91	13,99	,94	26 89	,96	33,89	,98	40,09	,98	51,09	,98	60 69	,97	172,9	1,00		
,90	14,49	,93	27,09	,97	33 99	,97	40,29	,97	51,49	,99	60,79	,99	175,9	,99		
,92	14 69	,94	27,19	,96	34,19	,98	40,49	,98	52,39	,98	61,49	,97	176,9	1,00		
,91	14,99	,93	27,29	,97	34,29	,97	40,69	,97	52,69	,99	61,69	,99	177,9	,99		
,92	15,09	,94	27,39	,96	34 39	,98	40,89	,98	53.09	,98	63,39	,97	178,9	1,00		
,91	15,59	,95	27,49	,97	34 59	,97	41,09	,97	53,39	,99	63,49	,99	180 9	,99		
,90	15,69	,94	27,59	,96	34,69	,98	41,29	,98	53,69	,98	———	———	181,9	1,00		
,91	15,79	,95	27,69	,97	34,79	,97	41,49	,97	54.09	,99	100,0	,99	183,9	,99		
,90	15,89	,94	27,79	,96	34,99	,98	41,69	,98	54,39	,98	142,9	1,00	184,9	1,00		
,92	15,99	,95	27,89	,97	35,19	,97	41,89	,97	54,69	,99	144,9	,99	187,9	,99		
	17,19	,94	28,49	,96	35,29	,98	42,89	,98	55,09	,98	148,9	1,00	188,9	1,00		
,99	17,29	,95	28,59	,97	35,39	,97	43,49	,99	55,39	,99	149,9	,99	193,9	,99		
,98	17,49	,94	28,69	,96	35,59	,98	43,59	,98	55,99	,97	155,9	1,00	194,9	1,00		
1,00	17,69	,95	28,79	,97	36,09	,97	48,09	,99	56,09	,99	156,9	,99	202,9	,99		
	20,59	,96	30,69	,96	36,19	,98	48,19	,98	56,59	,97	159,9	1,00	203,9	1,00		
1,00																
1,00																

EXAMPLE I.

Let the apparent distance of the moon's center from a star be 51° 28′ 35″ when the star's apparent altitude was 24° 48′ the moon's apparent altitude 12° 30′ and her horizontal parallax 56′ 15″. Required Their true Distance.

Star's apparent altitude,	24°	48′	Apparent distance,	51°	28′	35″	Logarithm from Tab. 9, Req. Tab. 9,99865
Moon's - - - - -	12	30	Diff. of apparent altitudes	12	18	0	
Difference of apparent altitudes,	12	18	Sum	63	46	35	Half is 31° 53″ 18′ log. sine 9,72285
Correction from tab. 8, Req. Tab.		50 42″	Difference	39	10	35	Half is 19 35 18 log. sine 9,52538
Star's refraction tab. 1, Req. Tab.		2 3	Logarithmic sum radius rejected - - - - -				19,24688
Difference of true altitudes,	11	25 15	5° 42′ 37½″ = log. sine 8,99783, which multiplied by 2 is				17,99566
Half difference is - -	5	42 37½					* 17,83 = 1,25122
							18,83 = 1,27492
							Half the above logarithm is 0,63746
* This falls in with direction 1st of the Table of Multipliers.	25	34 56					Half difference of true altitudes, log. sine 8,99783
		2					log. sine 9,63529
	51	9 52	True Distance.				

EXAMPLE II.

Let the apparent distance of the moon's center from the sun's be 59° 25′ 34″ when the sun's apparent altitude was 59° 12′, the moon's apparent altitude 27° 2′ and her horizontal parallax 59′ 58″. Required their True Distance.

Sun's apparent altitude,	59°	12′	Apparent distance,	59°	25′	34″	Logarithm from tab. 9, Req. Tab. 9,996719
Moon's - - - - -	27	2	Diff. of apparent altitudes,	32	10		
Difference of apparent altitudes,	32	10	Sum	91	35	34	Half is 45° 47′ 47″ log. sine 9,85543
Correction from tab. 8, Req. Tab.		51 33″	Difference	27	15	34	Half is 13 37 47 log. sine 9,37226
Sun's refrac. tab. 1, Req. Tab. 34″			Logarithmic sum radius rejected - - - - -				19,22441
Sun's paral. in alt. tab 3, Req. Tab. 4		30	15° 38′ 59″ = log. sine 9,43097, which multiplied by 2 is				18,86194
Difference of true altitudes,	31	17 57					* 2,303 = 0,36247
							3,303 = 0,51903
Half difference is - -	15	38 59					Half the above logarithm is 0,25951
							Half difference of true altitudes, log. sine 9,43097
* This falls in with direction 1st of the Table of Multipliers.	29	21 44					log. sine 9,69048
		2					
	58	43 28	True Distance.				

EXAMPLE III.

Let the apparent distance of the moon's center from a star be 46° 20′ when the star's apparent altitude was 19° 12′, the moon's apparent altitude 32° 14′ and her horizontal parallax 55° 12′. Required their True Distance.

Moon's apparent altitude,	32°	14′	Apparent distance,	46°	20′		Logarithm from tab. 9, Req. Tab. 9,996468
Star's - - - - -	19	12	Diff. of apparent altitudes,	13	2		
Difference of apparent altitudes,	13	2	Sum	59	22		Half is 29° 41′ log. sine 9,69478
Correction from tab. 8, Req. Tab.		45 11″	Difference	33	18		Half is 16 39 log. sine 9,45716
Star's refraction tab. 1, Req. Tab.		2 42	Logarithmic sum radius rejected - - - - -				19,14841
Difference of true altitudes,	13	49 53	6° 54′ 57″ = log. sine 9,08066, which multiplied by 2 is				18,16133
Half difference is - -	6	54 57					* 9,706 = 0,98708
							10,70 = 1,02966
							Half the above logarithm is 0,51483
* This falls in with direction 2d of the Table of Multipliers.	23	12 14					Half difference of true altitudes, log. sine 9,08066
		2					log. sine 9,59549
	46	24 28	True Distance.				

EXAMPLE IV.

Let the apparent distance of the moon's center from a star be 120° when the star's apparent altitude was 24° 30′. the moon's apparent altitude 20° 26′, and her horizontal parallax 54′ 16″. Required their True Distance.

Star's apparent altitude,	24° 30′		Apparent distance,	120° 0′	Logarithm from Tab. 9, Req. Tab.		9,997795
Moon's	20 26		Diff. of apparent altitudes,	4 4			
Difference of apparent altitudes,	4 4		Sum	124 4	Half is 62° 2′ log. sine		9,946069
Correction from tab. 8, Req. Tab.	48 19″		Difference	115 56	Half is 57 58 log. sine		9,928262
Star's refraction tab. 1, Req. Tab.	2 4		Logarithmic sum radius rejected				19,872126
			1° 38′ 49″ = log. sine 8,449615, which multiplied by 2 is				16,899230
Difference of true altitudes,	3 13 37				* 939,4 =		2,972896
Half difference is	1 36 49				940,4 =		2,973358
					Half the above logarithm is		1,486679
* This falls in with direction 3d of the Table of Multipliers.	59 43 8 2				Half difference of true altitudes, log. sine		8,449615
					log. sine		9,936294
	119 26 16	True Distance.					

EXAMPLE V.

Let the apparent distance of the moon's center from a star be 96° 4′ when the star's apparent altitude was 43° 32′, the moon's apparent altitude 40° 24′ and her horizontal parallax 54′ 22″. Required their True Distance.

Star's apparent altitude,	43° 32′		Apparent distance,	96° 4′	Logarithm from Tab. 9, Req. Tab.		9,995737
Moon's	40 24		Diff. of apparent altitudes,	3 8			
Difference of apparent altitudes,	3 8		Sum	99 12	Half is 49° 36′ log. sine		9,881692
Correction from tab. 8, Req. Tab.	40 16″		Difference	92 56	Half is 46 28 log. sine		9,860322
Star's refraction, tab. 1, Req. Tab.	1 0		Logarithmic sum radius rejected				19,737751
			1° 13′ 22″ = log. sine 8,329182, which multiplied by 2 is				16,658364
Difference of true altitudes,	2 26 44				*		3,079387
Half difference is	1 13 22				The above logarithm increased by the difference		3,079749
					Half the above logarithm is		1,539875
* This falls in with direction 4th of the Table of Multipliers.	47 42 22 2				Half difference of true altitudes, log. sine		8,329182
					log. sine		9,869057
	95 24 44	True Distance.					

EXAMPLE VI.

Let the apparent distance of the moon's center from a star be 118° 32′ when the star's apparent altitude was 29°, the moon's apparent altitude 29° 2′ and her horizontal parallax 61′ 18″. Required their True Distance.

Moon's apparent altitude,	29° 2′		Apparent distance,	118° 32′	Logarithm from Tab. 9, Req. Tab.		9,996416
Star's	29 0		Diff. of apparent altitudes,	0 2			
Difference of apparent altitudes,	0 2		Sum	118 34	Half is 59° 17′ log. sine		9,934349
Correction from tab. 8, Req. Tab.	51 53		Difference	118 30	Half is 59 15 log. sine		9,934199
Star's refraction tab. 1, Req. Tab.	1 42		Logarithmic sum radius rejected				19,864964
			0° 27 47½″ = log. sine 7,907589, which multiplied by 2 is				15,815178
Difference of true altitudes,	0 55 35				*		4,049786
Half difference is	0 27 47½				The above logarithm increased by one tenth of difference		4,049825
					Half the above logarithm is		2,024913
* This falls in with direction 5th of the Table of Multipliers.	58 52 35 2				Half the difference of true altitudes, log. sine		7,907589
					log. sine		9,932502
	117 45 10	True Distance.					

EXAMPLE VII.

Let the apparent diſtance of the moon's center from a ſtar be 87° 10′ when the ſtar's apparent altitude was 40° 12′, the moon's apparent altitude 39° 14′ and her horizontal parallax 58′ 9″. Required their True Diſtance.

Star's apparent altitude,	40° 12′		Apparent diſtance,	87° 10′	Logarithm from Tab. 9, Req. Tab.		9.995534
Moon's	39 14		Diff. of apparent altitudes,	0 58			
Difference of apparent altitudes,	0 58		Sum	88 8	Half is 44° 4′ log. ſine		9.842291
Correction from tab. 8, Req. Tab.	43 53″		Difference	86 12	Half is 43 6 log. ſine		9.834595
Star's refraction tab. 1, Req. Tab.	1 7		Logarithmic ſum radius rejected				19.672428
Difference of true altitudes,	0 13 0		0° 6′ 30″ = log. ſine 7.275351, which multiplied by 2 is				14.550702
Half difference is	0 6 30		The above logarithm increaſed by one hundredth of difference			*	5.121721
							5.121724
					Half the above logarithm is		2.560862
* This falls in with direction 6th of the Table of Multipliers.					Half difference of true altitudes, log. ſine		7.275351
	43 18 2					log. ſine	9.836213
	2						
	86 36 4	True Diſtance.					

EXAMPLE VIII.

Let the apparent diſtance of the moon's center from a ſtar be 104° 10′ when the ſtar's apparent altitude was 30° 35′, the moon's apparent altitude 29° 40′ and her horizontal parallax 60′ 54″. Required their True Diſtance.

Star's apparent altitude,	30° 35′		Apparent diſtance,	104° 10′	Logarithm from Tab. 9, Req. Tab.		9.996368
Moon's	29 40		Diff. of apparent altitudes,	0 55			
Difference of apparent altitudes,	0 55		Sum	105 5	Half is 52° 32′ 30″ log. ſine		9.899709
Correction from tab. 8, Req. Tab.	51 15″		Difference	103 15	Half is 51 37 30 log. ſine		9.894296
Star's refraction tab. 1, Req. Tab.	1 36		Logarithmic ſum radius rejected,				19.790373
Difference of true altitudes,	0 2 9		0° 1′ 4½″ = log. ſine 6.486303, which multiplied by 2 is				12.972606
Half difference is	0 1 4½					*	6.817767
					Half the above logarithm is		3.408884
* This falls in with direction 7th of the Table of Multipliers.					Half difference of true altitudes, log. ſine		6.486303
	51 46 26					log. ſine	9.895187
	2						
	103 32 52	True Diſtance.					

EXAMPLE IX.

Let the apparent diſtance of the moon's center from a ſtar be 72° when the ſtar's apparent altitude was 80° 4′, the moon's apparent altitude 12° 30′ and her horizontal parallax 53′ 10″. Required their True Diſtance.

Star's apparent altitude,	80° 4′		Apparent diſtance.	72° 0′	Logarithm from Tab. 9, Req. Tab.		9.998737
Moon's	12 30		Diff. of apparent altitudes,	67 34			
Difference of apparent altitudes,	67 34		Sum	139 34	Half is 69° 47′ log. ſine		9.972385
Correction from tab. 8, Req. Tab.	47 41″		Difference	4 26	Half is 2 13 log. ſine		8.587469
Star's refraction tab. 1, Req. Tab.	10		+ Logarithmic ſum radius rejected				18.558591
					Half the above logarithm is		9.279296
Difference of true altitudes,	66 46 9		33° 23′ 5″ = log. ſine 9.740566, which multiplied by 2 is				19.481132
Half difference is	33 23 5		Logarithmic ſum radius rejected				18.558591
						* 8.366 =	0.922541
						9.366 =	0.971574
* This falls in with direction 1ſt of the Table of Multipliers.					Half the above logarithm is		0.485787
					Half the logarithmic ſum radius rejected		9.279296
	35 36 23					log. ſine	9.765083
	2						
	71 12 46	True Diſtance.					

FINIS.